CLAIMS

1. (Original) An evaluation method that evaluates regularity and degree of a nonlinear distortion of a substrate, comprising:

obtaining, for a plurality of divided areas on a substrate, position deviation amounts relative to predetermined reference positions by detecting respective marks, which are provided corresponding to said plurality of divided areas; and

evaluating regularity and degree of a nonlinear distortion of said substrate by using an evaluation function that is used to obtain correlation, concerning at least direction, between a first vector representing said position deviation amount of a given divided area on said substrate and second vectors each of which represents said position deviation amount of a divided area of a plurality of divide areas around said given divided area.

2. (Original) An evaluation method according to claim 1, wherein said evaluation function is a function that is used to obtain correlation, concerning direction and size, between said first vector and said second vectors.

3. (Original) An evaluation method according to claim 1, wherein in addition, by using said evaluation function, a correlation value of a piece of position information used to align each of said divided areas with respect to a predetermined point is determined.

4. (Original) An evaluation method according to claim 1, wherein said evaluation function is a second function that represents an average of first N functions each of which is used to obtain correlation, concerning at least direction, between said first vector obtained by selecting a respective divided area of N divided areas on said substrate and said second

vectors each of which represents said position deviation amount of a divided area of a plurality of divide areas around said respective divided area of said N divided areas, N being a natural number.

5. (Original) A position detection method that detects pieces of position information to be used to align each of a plurality of divided areas on a substrate with respect to a predetermined point, said method comprising:

calculating said piece of position information through use of a statistic computation using measured position information obtained by detecting said plurality of marks on said substrate; and

determining, for said piece of position information, at least one of a correction value and a correction parameter that determines said correction value, by using a function that is sued to obtain correlation, concerning at least direction, between a first vector representing a position deviation amount of a given divided area on said substrate and second vectors each of which represents a position deviation amount of a divided area of a plurality of divide areas around said given divided area, said position deviation amount of said first vector being relative to a predetermined reference position, said position deviation amounts of said second vectors being relative to respective predetermined reference positions.

6. (Original) A position detection method according to claim 5, wherein, through said statistic computation, said pieces of position information having a linear component of a position deviation amount thereof corrected are calculated for said plurality of divided areas, and wherein at least one of said correction value and said correction parameter is determined

by using said function so that a nonlinear component of said position deviation amount is correlated.

7. (Original) A position detection method according to claim 5, wherein said measured position information is in accord with position deviations of said divided areas relative to said predetermined point specified in design-position information, and wherein by performing a statistic computation using said measured position information obtained from measuring at least three specific divided areas of said plurality of divided areas on said substrate, parameters of a conversion equation that calculates said pieces of position information are obtained.

8. (Original) A position detection method according to claim 7, wherein parameters of said conversion equation are calculated with said measured position information being weighted with an amount for each of said specific divided areas, and wherein said weighting amount is determined by using said function.

9. (Original) A position detection method according to claim 5, wherein said measured position information contains coordinates of said marks in a stationary coordinate system defining movement position of said substrate, and wherein said pieces of position information are coordinates of said divided areas in said stationary coordinate system.

10. (Original) A position detection method according to claim 5, wherein said correction values of said pieces of position information are determined based on a complement function optimized using said function.

11. (Original) An exposure method that forms a predetermined pattern on each of a plurality of divided areas on a plurality of substrates by sequentially performing exposure of said plurality of divided areas on said plurality of substrates, said exposure method comprising:

detecting a piece of position information of each divided area on an n'th substrate of said plurality of substrates by using a position detection method according to claim 5, said n being larger than or equal to two; and

performing, after having moved each of said divided areas to an exposure reference position based on said detection results, exposure on said divided area.

12. (Original) A device manufacturing method including a lithography process, wherein in said lithography process, exposure is performed by using an exposure method according to claim 11.

13. (Currently Amended) A position detection method that detects a piece of position information to be used to align each of a plurality of divided areas on a substrate with respect to a predetermined point, wherein, for a second or later (n'th) substrate of said plurality of substrates, so as to detect a piece of position information of each of said plurality of divided areas of a plurality of substrates, are used a linear component of a piece of position information of said divided area obtained by performing a statistic computation using measured position information in accord with position deviations of at least three specific divided areas relative to said predetermined point specified in design-position information, and a nonlinear component of a piece of position information of said divided area on at least

one of substrates earlier than said n'th substrate, said measured position information being measured by detecting a plurality of marks on said n'th substrate,

wherein said nonlinear component of a piece of position information of each of said divided areas is calculated based on a single complement function optimized based on indices of regularity and degree of a nonlinear distortion, of at least one of substrates earlier than said n'th substrate, that are obtained by, through use of a predetermined evaluation function, evaluating pieces of measured position information of said divided areas on said substrate, and based on a nonlinear component of a piece of position information of said divided area on at least one of substrates earlier than said n'th substrate.

14. (Canceled)

15. (Currently Amended) A position detection method according to claim ~~14~~ 13, wherein said complement function is a function expanded by ~~the~~ Fourier series, and wherein based on results of said evaluation a highest order of said Fourier series expansion is optimized.

16. (Original) A position detection method according to claim 14, wherein said nonlinear component of said piece of position information of each of said divided areas is calculated based on a difference between a piece of position information of said divided area, which is calculated by weighting measured position information, which is obtained by detecting a plurality of marks on said at least one of substrates earlier than said n'th substrate, and performing a statistic computation using said weighted information, and a piece of position information of said divided are calculated by performing a statistic computation

using measured position information, which is obtained by detecting a plurality of marks on said at least one of substrates earlier than said n'th substrate.

17. (Original) An exposure method that forms a predetermined pattern on each of a plurality of divided areas on a plurality of substrates by sequentially performing exposure of said plurality of divided areas on said plurality of substrates, said exposure method comprising:

detecting a piece of position information of each divided area on an n'th substrate of said plurality of substrates by using a position detection method according to claim 14, said n being larger than or equal to two; and

performing, after having moved each of said divided areas to an exposure reference position based on said detection results, exposure on said divided area.

18. (Original) A device manufacturing method including a lithography process, wherein in said lithography process, exposure is performed by using an exposure method according to claim 17.

19. (Original) A position detection method that detects a piece of position information to be used to align each of a plurality of divided areas on a substrate with respect to a predetermined point, said method comprising:

grouping, for a second or later (n'th) substrate of a plurality of substrates, a plurality of divided areas on said substrate into blocks beforehand based on indices representing regularity and degree of a nonlinear distortion of at least one of substrates earlier than said n'th substrate so as to detect a piece of position information of each of said plurality of

divided areas of said plurality of substrates, said indices being obtained by evaluating, through use of a predetermined evaluation function, measured position information in accord with position deviations, relative to said predetermined point, of said divided areas on said at least one of substrates earlier than said n'th substrate; and

determining said pieces of position information of al divided areas belonging to each of said blocks by using measured position information in accord with position deviations, relative to said predetermined point, of a second number of divided areas, said second number being smaller than a first number, which represents a total number of divided areas belonging to each of said blocks.

20. (Original) An exposure method that forms a predetermined pattern on each of a plurality of divided areas on a plurality of substrates by sequentially performing exposure of said plurality of divided areas on said plurality of substrates, said exposure method comprising:

detecting a piece of position information of each divided area on an n'th substrate of said plurality of substrates by using a position detection method according to claim 19, said n being larger than or equal to two; and

performing, after having moved each of said divided areas to an exposure reference position based on said detection results, exposure on said divided area.

21. (Original) A device manufacturing method including a lithography process, wherein in said lithography process, exposure is performed by using an exposure method according to claim 20.

22. (Original) A position detection method that detects a piece of position information to be used to align each of a plurality of divided areas on a substrate with respect to a predetermined point, said method comprising:

determining a weight parameter for weighting, by using a function that is used to obtain correlation, concerning at least direction, between a first vector representing a position deviation amount of a given divided area on said substrate and second vectors each representing a position deviation amount of a divided area of a plurality of divide areas around said given divided area, said position deviation amount of said first vector being relative to a predetermined reference position, said position deviation amounts of said second vectors being relative to said predetermined reference position; and

weighting measured position information, obtained by detecting a plurality of marks on said substrate, by using said weight parameter and calculating said piece of position information by a statistic computation using said weighted, measured position information.

23. (Original) An exposure method that forms a predetermined pattern on each of a plurality of divided areas on a plurality of substrates by sequentially performing exposure of said plurality of divided areas on said plurality of substrates, said exposure method comprising:

detecting a piece of position information of each divided areas on an n'th substrate of said plurality of substrates by using a position detection method according to claim 22, said n being larger than or equal to two; and

performing, after having moved each of said divided areas to an exposure reference position based on said detection results, exposure on said divided area.

24. (Original) A device manufacturing method including a lithography process, wherein in said lithography process, exposure is performed by using an exposure method according to claim 23.

25. (Original) An exposure method that forms a predetermined pattern on each of a plurality of divided areas on a substrate by sequentially performing exposure of said plurality of divided areas on said substrate, said exposure method comprising:

making, for each of at least two conditions concerning said substrate, beforehand at least a correction map based on measurement results of a plurality of marks on a specific substrate, said correction map being composed of pieces of correction information used to correct nonlinear components of position deviation amounts, relative to respective reference positions, of a plurality of divided areas on said substrate;

selecting a correlation map corresponding to a designated condition before exposure; and

calculating pieces of position information used to align each divided area with respect to a predetermined point, through use a statistic computation, based on measured position information obtained by detecting a plurality of marks provided corresponding to each of a plurality of specific divided areas on said substrate and performing, after having moved said substrate based on said pieces of position information and said selected correction map, exposure on said divided areas.

26. (Original) An exposure method according to claim 25,

wherein said at least two conditions include at least two process conditions through which substrates have been,

wherein upon said map making, said correction map is made for each of a plurality of specific substrates that have been through different processes, and

wherein upon said selection, a correction map is selected that corresponds to a substrate subject to exposure.

27. (Original) An exposure method according to claim 25,

wherein said at least two conditions include at last two conditions concerning selection of said plurality of specific divided areas of which said marks are detected to obtain said measured position information,

wherein upon said map making, position deviation amounts relative to respective reference positions of a plurality of divided areas on said specific substrate are obtained by detecting marks provided corresponding to each of said plurality of divided areas on said specific substrate, wherein pieces of position information of said divided areas are calculated through use of a statistic computation using measured position information obtained by detecting marks corresponding to a plurality of specific divided areas that are corresponding to said condition and are on said specific substrate, for each of said conditions concerning selection of said specific divided areas, and wherein a correction map is made based on said pieces of position information and said position deviation amounts of said divided areas, said correction map being composed of pieces of correction information used to correct nonlinear components of position deviation amounts, relative to respective reference position, and said divided areas; and

wherein upon said selection, a correction map is selected that corresponds to designated selection information of specific divided areas.

28. (Original) An exposure method according to claim 25,

wherein said specific substrate is a reference substrate.

29. (Original) An exposure method according to claim 25,

wherein upon said exposure, if divided areas on said substrate subject to exposure include an imperfect area which is in periphery of said substrate and of which a piece of correction information is not containing in said correction map, a piece of correction information of said imperfect area is calculated by a weighted-average computation based on a Gauss distribution and using pieces of correction information, contained in said correction map, of a plurality of divided areas adjacent to said imperfect area.

30. (Original) A device manufacturing method including a lithography process, wherein in said lithography process, exposure is performed by using an exposure method according to claim 25.

31. (Original) An exposure method that forms a predetermined pattern on each of a plurality of divided areas on a substrate by sequentially performing exposure of said plurality of divided areas on said substrate, said exposure method comprising:

measuring pieces of position information of mark areas each corresponding to a respective mark by detecting a plurality of marks on a reference substrate;

obtaining, by a statistic computation using said pieces of measured position information, pieces of calculated position information of said mark areas, each having a linear component of position deviation amount thereof, relative to a design value of a respective mark area, corrected;

making a first correction map including pieces of correction information used to correct nonlinear components of position deviation amounts of said mark areas, based on said pieces of measured position information and said pieces of calculated position information, each of said position deviation amounts being relative to a design value of a respective mark area;

converting, before exposure, said first correction map to a second correction map, based on information concerning a designated arrangement of divided areas, said second correction map including pieces of correction information used to correct nonlinear components of position deviation amounts of said divided areas, each of said position deviation amounts being relative to a reference position of a respective divided area of said divided areas; and

calculating pieces of position information, used to align each divided area with respect to a predetermined point, through use of a statistic computation based on measured position information obtained by detecting a plurality of marks on said substrate and performing, while moving said substrate based on said pieces of position information and said second correction map, exposure on said divided areas.

32. (Original) An exposure method according to claim 31,

wherein in said map conversion, a piece of correction information of a reference position on each of said divided areas is calculated by a weighted-average computation assuming a Gauss distribution, based on pieces of correction information of a plurality of mark areas adjacent to said reference position.

33. (Original) A position detection method according to claim 31, wherein said map conversion is realized by, for a reference position on each of said divided areas, performing a complement computation based on pieces of correction information of said mark areas and a single complement function optimized based on results of evaluating, through use a predetermined evaluation function, regularity and degree of a nonlinear distortion of a region of a substrate.

34. (Original) A device manufacturing method including a lithography process, wherein in said lithography process, exposure is performed by using an exposure method according to claim 31.

35. (Original) An exposure method that forms a predetermined pattern on each of a plurality of divided areas on a plurality of substrates by using a plurality of exposure apparatuses including at least one exposure apparatus capable of correcting distortion of projected image and sequentially performing exposure of said divided areas on said substrates, said exposure method comprising:

an analysis step of analyzing overlay error information, measured beforehand, of at least one specific substrate that has been through the same process as said substrates;

a first judgment step of judging, based on said analysis results, whether or not errors between divided areas on said specific substrate are predominate, said errors between divided areas being caused by position deviation amounts having different translation components from each other;

a second judgment step of, when in said first judgment step it has been judged that said errors between divided areas are predominant, judging whether or not said errors between divided areas have a nonlinear component;

a first exposure step of, when in said second judgment step it has been judged that said errors between divided areas have no nonlinear component, with using an arbitrary exposure apparatus, calculating pieces of position information used to align each divided area with respect to a predetermined point, by a statistic computation using measured position information obtained by detecting marks corresponding to each of a plurality of specific divided areas on each of said plurality of substrates and sequentially performing exposure on said plurality of divided areas of each of said plurality of substrates so as to form said pattern on each divided area, while moving said substrate based on said pieces of position information;

a second exposure step of, when in said second judgment step it has been judged that said errors between divided areas have a nonlinear component, with using an exposure apparatus that can perform exposure on substrates correcting said errors between divided areas, sequentially performing exposure on said plurality of divided areas of each of said plurality of substrates so as to form said pattern on each divided area; and

a third exposure step of, when in said first judgment step it has been judged that said errors between divided areas are not predominant, selecting an exposure apparatus capable of correcting distortion of said projected image and, with using said selected exposure apparatus, sequentially performing exposure on said plurality of divided areas of each of said plurality of substrates so as to form said pattern on each divided area.

36. (Original) An exposure method according to claim 35, further comprising:

a selection step of, when in said second judgment step it has been judged that said errors between divided areas have a nonlinear component, selecting said instructing an exposure apparatus that can perform exposure on substrates correcting said errors between divided areas to perform exposure;

a third judgment step of judging how large differences of overlay errors between a plurality of lots are, said lots including a lot to which a substrate subject to exposure belongs; and

wherein in said second exposure step, when upon sequentially performing exposure on said plurality of divided areas of each of said plurality of substrates so as to form said pattern on each divided area, in said third judgment step it has been judged that differences of overlay errors between lots are large, said exposure apparatus, for each of a predetermined number of first and following substrates of said lot, calculates pieces of position information used to align each divided areas with respect to a predetermined point, by a statistic computation using a measured position information obtained by detecting a plurality of marks on said substrate, calculates nonlinear components of position deviation amounts, relative to respective predetermined reference positions, of said divided areas by using said measured position information and a predetermined function, and moves said substrate based on said pieces of position information calculated and said nonlinear components, and for each of the other substrates, calculates pieces of position information used to align each divided area with respect to a predetermined point, by a statistic computation using measured position information obtained by detecting a plurality of marks on said substrate, and moves said substrate based on said pieces of position information calculated and said nonlinear components calculated, and

wherein when in said third judgement step it has been judged that differences of overlay errors between lots are no large, said exposure apparatus, for each substrate of said lot, calculates pieces of position information used to align each divided area with respect to a predetermined point, by a statistic computation using measured position information obtained by detecting a plurality of marks on said substrate, and moves said substrate based on said pieces of position information calculated and a correction map that is made beforehand and composed of pieces of correction information used to correct nonlinear components of position deviation amounts, relative to respective reference positions, of a plurality of divided areas on a substrate.

37. (Original) A device manufacturing method including a lithography process, wherein in said lithography process, exposure is performed by using an exposure method according to claim 35.

38. (Original) An exposure apparatus that forms a predetermined pattern on each divided area on a plurality of substrates by performing exposure on said substrates, said exposure apparatus comprising:

a judgment unit of judging how large differences of overlay errors between a plurality of lots are, said lots including a lot to which a substrate subject to exposure belongs;

a first controller that, when said judgment unit judges that differences of overlay errors between lots are large, upon exposure for each of a predetermined number of first and following substrates of said lot, calculates pieces of position information used to align each divided area with respect to a predetermined point, by a statistic computation using measured position information obtained by detecting a plurality of marks on said substrate, calculates

nonlinear components of position deviation amounts, relative to respective predetermined reference positions, of said divided areas by using said measured position information and a predetermined function, and moves said substrate based on said pieces of position information calculated and said nonlinear components, and upon exposure for each of the other substrates in said lot, calculates pieces of position information used to align each divided area with respect to a predetermined point, by a statistic computation using measured position information obtained by detecting a plurality of marks on said substrate, and moves said substrate based on said pieces of position information calculated and said nonlinear components calculated; and

a second controller that, when said judgment unit judges that differences of overlay errors between lots are not large, upon exposure for each substrate of said lot, calculates pieces of position information used to align each divided area with respect to a predetermined point, by a statistic computation using measured position information obtained by detecting a plurality of marks on said substrate, and moves said substrate based on said pieces of position information calculated and a correction map that is made beforehand and composed of pieces of correction information used to correct nonlinear components of position deviation amounts, relative to respective reference positions, of a plurality of divided areas on a substrate.

39. (Original) An exposure method that forms a predetermined pattern on each of a plurality of divided areas on a substrate by performing exposure on said divided area, said exposure method comprising:

selecting a first alignment mode, when, based on overlay error information of an exposure apparatus used in exposure of said substrate, errors between divided areas on said

substrate are predominant, and a second alignment mode different from said first alignment mode, when errors between divided areas on said substrate are not predominate; and

determining respective pieces of position information of said divided areas based on pieces of position information obtained by detecting a plurality of marks on said substrate using said selected alignment mode.